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मोटर वाहन हेतु इस्पात नलिकाएँ — विशिष्टि

(तीसरा पुनरीक्षण)

Indian Standard

STEEL TUBES FOR AUTOMOTIVE PURPOSES — SPECIFICATION

(Third Revision)

ICS 43.020; 77.140.75

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Steel Tubes, Pipes and Fittings Sectional Committee, MTD 19

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Steel Tubes, Pipes and Fittings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1965 and subsequently revised in 1979 and 2005. As a result of the experience gained since its publication, it has been decided to revise this standard incorporating the following changes:

a) Weldability and appearance clause have been included in this standard in line with ISO 3305.
b) Annex has been added to elaborate method of eddy current testing of tubes as an alternate to the leak tightness test.
c) Due consideration has been given in this revision with regard to use of hot rolled and cold reduced low carbon steel sheet and strip.
d) The chemical composition for different types of steel for Electric resistance welded/High frequency induction welded steel tubes have been derived from IS 1079, IS 513 and IS 10748.

In the formulation of this standard due weightage has been given to international co-ordination among the standards prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following publications:

ISO 3304 : 1985	Plain end seamless precision steel tubes — Technical conditions for delivery
ISO 3305 : 1985	Plain end welded precision steel tubes — Technical conditions for delivery
ISO 3306 : 1985	Plain end as welded and sized precision steel tubes — Technical conditions for delivery
BS EN 10305-1 : 2002 (E)	Steel tubes for precision applications — Technical delivery conditions — Part 1: Seamless cold drawn tubes
BS EN 10305-2 : 2010 (E)	Steel tubes for precision applications — Technical delivery conditions — Part 2: Welded cold drawn tubes
BS EN 10305-3 : 2010 (E)	Steel tubes for precision applications — Technical delivery conditions — Part 3: Welded cold sized tubes

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical value (***revised***)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

STEEL TUBES FOR AUTOMOTIVE PURPOSES — SPECIFICATION

(Third Revision)

1 SCOPE

This standard covers the requirements for steel tubes for use in automotives including two and three wheelers, in sizes up to and including 114.3 mm outside diameter and these are indicated in the following sections:

Section 1	General requirements
Section 2	Cold drawn seamless steel tubes (CDS)
Section 3	Electric resistance welded/high frequency induction welded steel tubes (ERW/HFIW)
Section 4	Cold drawn electric resistance welded/high frequency induction welded steel tubes (CEW)

1.2 Details of the grades of tube and materials dealt with under each type are given in subsequent clauses.

1.3 All steel tubes covered by this standard shall comply with the requirement laid down in Section 1 and in addition with the requirements under each appropriate section.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed below:

IS No.	*Title*
228 (In parts)	Methods of chemical analysis of steels
513 : 2008	Cold-reduced low carbon steel sheet and strip (*fifth revision*)
1079 : 2009	Hot-rolled low carbon steel sheet and strip (*sixth revision*)
1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
1608 : 2005/ ISO 6892 : 1998	Metallic materials — Tensile testing at ambient temperature (*third revision*)
2328 : 2005/ ISO 8492 : 1998	Metallic materials — Tube — Flattening test (*second revision*)
2335 : 2005/ ISO 8493 : 1998	Metallic materials — Tube — Drift expanding test (*second revision*)
4711 : 2008	Methods for sampling of steel pipes, tubes and fittings (*second revision*)
4740 : 1979	Code of practice for packaging of steel tubes (*first revision*)
5429 : 1979	Dimensions for steel tubes for automotive purposes (*first revision*)
10748 : 2004	Hot-rolled steel strip for welded tubes and pipes — Specification (*second revision*)

Section 1 General Requirements

3 SUPPLY OF MATERIAL

General requirements relating to the supply of materials shall be as laid down in IS 1387.

4 MATERIAL

4.1 The steel tubes shall be manufactured from steel produced by open-hearth, electric, duplex or one of the basic oxygen processes or a combination of these processes. In case, any other process is employed in the manufacture, prior approval of the purchaser shall be obtained.

4.2 Steel shall be supplied in killed condition and free from harmful defects.

NOTE — This excludes the use of rimming or semi-killed steel.

5 WORKMANSHIP

5.1 The tubes shall have smooth external and internal surfaces, the degree of smoothness depending on method of manufacture. The tubes shall have workmanlike finish but small imperfections are permissible provided that the thickness remains within the lower tolerance limit. Thickness at the weld shall be within the stipulated tolerances. In the case of tubes with an inside diameter less than 16 mm, for manufacturing reasons the requirement regarding the smooth internal surface is not fully observable. Cold finished tubes are permitted to have an adherent layer of phosphate and lubricant originating from the drawing process on the internal and external surface. Tubes annealed or normalized in a controlled atmosphere may have discoloration but shall be free from loose scale.

5.2 Surface imperfections may be dressed provided that the thickness after dressing remains within the lower tolerance limit. Peening of surface defect is not permitted.

5.3 Ends of tubes shall be cut square, if required by the purchaser.

6 STRAIGHTNESS

Unless otherwise agreed to between the purchaser and the manufacturer, tubes shall not deviate from straightness by more than 1/600th of any length, measured at the centre of that length.

7 CHEMICAL COMPOSITION

7.1 The analysis of steel shall be carried out either by the method specified in IS 228 and its relevant parts or any other established instrumental/chemical methods. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method. However, where method is not given in IS 228 and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

7.1.1 *Product Analysis*

If so agreed between the purchaser and the manufacturer, the product analysis may be carried out. Maximum permissible variations in the case of product analysis over the maximum limits specified in Tables 2, 4 and 6 shall be as given in Table 1.

Table 1 Permissible Variations for Products Analysis

Constituent (1)	Variation Over the Specified Limit Percent, *Max* (2)
C	0.02
Mn	0.05
S	0.005
P	0.005

8 MECHANICAL PROPERTIES

The mechanical properties depend on the delivery conditions. They are specified in Tables 3, 5 and 7.

8.1 Mechanical Tests

All tests shall be carried out at ambient temperature.

8.2 Tensile Tests

Tensile test shall be made on lengths cut from the ends of selected tubes (the ends being plugged for grips where necessary or pressed flat by pressing machine/hammering) or on longitudinal strips, not including the weld, cut from tubes. The tensile strength, yield stress and the percentage elongation shall be determined in accordance with IS 1608 and shall be not less than that specified.

NOTES

1 The specification does not stipulate upper limits for tensile and yield strength for any grade of material.

2 There is no correlation between the values of ultimate tensile strength and yield strength specified for different grades.

8.3 Flattening Test

Flattening test shall be made on lengths cut from the ends of selected tubes in accordance with IS 2328. The tubes shall be capable without showing crack or flaw of being flattened until the distance between the parallel plates is not more than specified. In the case of welded tubes the weld shall be placed at the point of maximum curvature. The burrs may be removed before testing. Superficial ruptures resulting from surface imperfection shall not be the cause of rejection. Flattening test of welded tubes shall be done by placing the weld at both top (12 O'clock position) and at side (3 O' clock position).

8.4 Crushing Test

The test piece shall be capable of being crushed endwise without cracking, until its length is reduced by at least the specified percentage of the original length. The length of the test piece shall be about one and a half times the outside diameter of the tube and the ends shall be cut square to the axis of the tube.

8.5 Drift Test

This test shall be carried out in accordance with IS 2335. Pieces of suitable length cut from the tubes shall be capable without cracking of being drifted to an included angle of 30° until the outside diameter is increased by not less than the amount specified. For the purpose of this test tubes shall not be belled by spinning methods.

8.6 Re-test

Should anyone of the test pieces first selected, fail to pass any of the tests specified, two further samples shall be selected for testing in respect of each failure. In case the test pieces from both of these additional samples pass, the materials shall be deemed to comply with the requirements of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be deemed as not complying with the standard or the manufacturer may select to test individually the remaining lengths in the lot for the test failed to comply in the preceding tests.

8.7 Sampling

8.7.1 ***Sampling of Tubes***

For the purpose of drawing samples all steel tubes bearing same designation and manufactured under a single process shall be grouped together to constitute a lot. Each lot shall be sampled separately and assessed for conformity to this specification.

8.7.2 ***Sampling and Criterion for Conformity***

Unless otherwise agreed to between the manufacturer and the purchaser or otherwise specified in this standard the procedure for sampling of tubes for various tests and criteria for conformity shall be as given in IS 4711.

8.8 Weldability

Tubes in annealed or normalized condition are suitable for welding without special parameters. For cold-drawn tubes which are welded or brazed, the mechanical properties in the heat affected zone may be affected by the welding temperature.

9 DIMENSIONS AND TOLERANCES

The dimensions and tolerances on thickness and diameter shall be in accordance with IS 5429.

10 SURFACE PROTECTION

The tubes shall be delivered with surface protection. Unless otherwise agreed, the manufacturer's standard mill protection may be used.

11 MARKING

11.1 Each bundle of tube shall be suitably identified with the manufacturer's name or trade-mark, size, type and grade designation of the tube.

11.2 BIS Certification Marking

The tubes may also be marked with the Standard Mark.

11.2.1 The use of the Standard Mark is governed by the provisions of the ***Bureau of Indian Standards Act***, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

12 BUNDLING AND PACKING

Bundling and packing of tubes shall be as mutually agreed to between the manufacturer and the purchaser.

Section 2 Cold Drawn Seamless Steel Tubes (CDS)

13 GENERAL

13.1 This section covers cold drawn seamless steel tubes designated as CDS-1, CDS-2, CDS-3, CDS-4, CDS-5, CDS-6, CDS-7, CDS-8, CDS-9.

13.2 Tubes shall comply in all respects with the requirements specified in Sections 1 and 2 of this standard and shall be subjected to both chemical analysis and mechanical tests.

14 CHEMICAL COMPOSITION

The Ladle Sample Analysis (LSA) reported by the steel producer shall apply and comply with the requirement of Table 2.

15 CONDITION

Tubes shall be supplied in any one of the conditions specified in Table 3.

16 NUMBER OF MECHANICAL TESTS

Unless otherwise specified, the number of tests shall be at the rate of one set of tests per 200 numbers of tubing or part thereof.

17 MECHANICAL PROPERTIES

The mechanical properties obtained from test pieces selected and prepared as specified under **6** shall be within the limits specified in Table 3.

18 FLATTENING TEST

The flattening test shall be carried out, as specified in IS 2328 (***see also*** **8.3**), on annealed and normalized tubes. The distance between the parallel plates shall not be greater than calculated from the following formula:

$$\boldsymbol{H} = \frac{(\boldsymbol{I} + \boldsymbol{C})\boldsymbol{t}}{\boldsymbol{C} + \boldsymbol{t}/\boldsymbol{D}}$$

where

H = distance between flattening plates keeping weld at 90° in mm;

t = specified wall thickness of tube, in mm;

D = specified outside diameter of the tube in mm; and

C = deformation factor (values are given below).

Table 2 Chemical Composition for Cold Drawn Seamless Steel Tubes (CDS)
(*Clause* 14)

Grade Designation (1)	**C** Percent (2)	**Si** Percent (3)	**Mn** Percent (4)	**Ni** Percent (5)	**Cr** Percent (6)	**Mo** Percent (7)	**S** ***Max*** (8)	**P** ***Max*** (9)
CDS-1	0.20 ***Max***	—	0.30 – 0.60	—	—	—	0.04	0.04
CDS-2	0.10 – 0.18	—	0.40 – 0.70	—	—	—	0.04	0.04
CDS-3	0.10 – 0.20	—	0.60 – 0.90	—	—	—	0.04	0.04
CDS-4	0.30 – 0.40	—	0.60 – 0.90	—	—	—	0.04	0.04
CDS-5	0.45 – 0.55	—	0.60 – 0.90	—	—	—	0.04	0.04
CDS-6	0.16 – 0.24	0.10 – 0.35	1.30 – 1.70	—	—	—	0.04	0.04
CDS-7	0.26 ***Max***	0.10 – 0.35	0.50 – 0.80	—	0.90 – 1.20	0.20 – 0.35	0.04	0.04
CDS-8	0.35 – 0.45	0.10 – 0.35	0.50 – 0.80	—	0.90 – 1.20	0.20 – 0.35	0.04	0.04
CDS-9	0.10 – 0.20	0.10 – 0.35	0.60 – 1.00	0.60 –1.00	0.40 – 0.80	—	0.04	0.04

Table 3 Mechanical Properties for Cold Drawn Seamless Steel Tubes (CDS)
(*Clauses* 15 *and* 17)

Grade Designation (1)	**Conditions** (2)	**Tensile Strength** MPa (kgf/mm^2) ***Min*** (3)	**Yield Stress** MPa (kgf/mm^2) ***Min*** (4)	**Crushing Test** Percent, ***Min*** (5)
CDS-1	a) As drawn or as drawn and tempered	430 (44)	370 (38)	25
	b) As drawn and normalized/ annealed	310 (32)	160 (17)	50
	c) As drawn and brazed or welded	310 (32)	160 (17)	—
CDS-2	a) As drawn or as drawn and tempered	430 (44)	370 (38)	25
	b) As drawn and normalized/ annealed	310 (32)	160 (17)	50
	c) As drawn and brazed or welded	310 (32)	160 (17)	—
CDS-3	a) As drawn or as drawn and tempered	430 (44)	370 (38)	25
	b) If subsequently annealed, brazed or welded	330 (34)	180 (19)	—
CDS-4	a) As drawn or as drawn and tempered	570 (58)	460 (47)	25
	b) As drawn and normalized/ annealed	430 (44)	270 (28)	50
	c) As drawn and brazed or welded	430 (44)	270(28)	—
CDS-5	a) As drawn or as drawn and tempered	690 (70)	590 (60)	—
	b) As drawn and normalized/ annealed	510 (52)	330 (34)	25
	c) As drawn and brazed or welded	510 (52)	330 (34)	—
CDS-6	a) As drawn or as drawn and tempered	630 (64)	510 (52)	—
	b) As drawn and normalized/ annealed	470 (48)	270 (28)	25
	c) As drawn and brazed or welded	470 (48)	270 (28)	—
CDS-7	a) As drawn or as drawn and tempered	710 (72)	590 (60)	—
	b) If subsequently annealed, brazed or welded	550 (56)	390 (40)	—
CDS-8	As drawn or heat-treated	710 (72)	590 (60)	—
CDS-9	Oil quenched and tempered	640 (65)	440 (45)	50

NOTE — 1 MPa = 1 N/mm^2 = 1 MN/m^2 = 0.102 kgf/mm^2.

Grade Designation	*Deformation Factor, C*
CDS-1(b), CDS-2(b), CDS-3(b)	0.09
CDS-4(b)	0.07
CDS-5(b), CDS-6(b), CDS-7(b)	0.06

Section 3 Electric Resistance Welded/High Frequency Induction Welded Steel Tubes (ERW/HFIW)

19 GENERAL

19.1 This section of the standard covers three grades of electric resistance welded/high frequency induction welded steel tubes, designated as ERW-1, ERW-2 and ERW-3.

19.1.1 Tubes shall be manufactured from either hot or cold rolled steel strip and longitudinally resistance welded continuously by the passage of an electric current across the abutting edges/high frequency current is induced in the open seam tube by an induction coil located ahead of the weld point and shall comply in all respects with the requirements specified in Sections 1 and 3.

20 CHEMICAL COMPOSITION

The Ladle Sample Analysis (LSA) reported by the steel producer shall apply and comply with the requirement of Table 4.

Table 4 Chemical Composition for Electric Resistance Welded/High Frequency Induction Welded Steel Tubes (ERW/HFIW)
(*Clause* 20)

Grade Designation (1)	**C** Percent *Max* (2)	**Mn** Percent *Max* (3)	**S** Percent *Max* (4)	**P** Percent *Max* (5)
ERW-1	0.12	0.60	0.04	0.04
ERW-2	0.25	1.20	0.04	0.04
ERW-3	0.35	1.30	0.04	0.04

NOTES

1 Micro-alloying elements like Niobium (Nb), Vanadium (V), Titanium (Ti) and Boron (B) either individually or in combination may be permissible in all grades but total micro-alloying elements should not exceed 0.2 percent in ladle analysis. However, in case of boron, the limit shall be 0.006 percent.

2 Grade Designation ERW-2: For each reduction of 0.01 percentages point below specified maximum of carbon (C), an increase of 0.05 percentage point above the specified maximum for manganese (Mn) is permitted up to a maximum of 1.60 percent.

21 CONDITION

Tubes shall be supplied as welded with the external weld bead (fin) removed and flush with the surface. In fin cut condition the maximum height of the weld bead shall not be more than 0.20 mm or otherwise as agreed to between the manufacturer and the purchaser. All tubes shall be of workman like finish free from injurious defects and shall be reasonably straight. The tubes may be supplied in heat treated condition provided that all the requirements of this standard are complied with.

22 MECHANICAL PROPERTIES

The mechanical properties obtained from test pieces selected and prepared as specified in **8** shall be within the limits specified in Table 5.

23 LEAK TIGHTNESS TEST

23.1 When required by the purchaser each tube shall be tested for leak tightness as in-process at manufacturers works either by hydraulic test at a pressure of 5 MPa (50 Bar) or alternatively by eddy

Table 5 Mechanical Properties for Electric Resistance Welded/High Frequency Induction Welded Steel Tubes (ERW/HFIW)
(*Clause* 22)

Grade Designation (1)	**Tensile Strength** MPa (kgf/mm^2) ***Min*** (2)	**Yield Stress** MPa (kgf/mm^2) ***Min*** (3)	**Percent Elongation on** $5.65\sqrt{So}$ **(Gauge Length)** (4)	**Distance Between Parallel Plate** (5)	**Drifting Test Percent** ***Min*** (6)
ERW-1	310 (32)	160 (17)	20	2t	12½
ERW-2	380 (39)	240 (25)	15	3t	10
If subsequently annealed, brazed or welded	330 (34)	180 (19)	—	—	—
ERW-3	430 (44)	270 (28)	10	5t	7½
If subsequently annealed, brazed or welded	380 (39)	240 (25)	—	—	—

NOTE — 1 MPa = 1 N/mm^2 = 1 MN/mm^2 = 0.102 kgf/mm^2.

current test, in accordance with Annex A.

23.2 The hydraulic test pressure shall be maintained in each tube for at least 5 s and there shall be no sign of leakage during the test.

Section 4 Cold Drawn Electric Resistance Welded/High Frequency Induction Welded Steel Tubes (CEW)

24 GENERAL

24.1 This section of the standard covers three grades of electric resistance weld/high frequency induction welded and subsequently cold drawn steel tubes, designated as CEW-1, CEW-2 and CEW-3.

24.2 The tubes shall comply in all respects with the requirements specified in Sections 1 and 4 and shall be subjected to both chemical analysis and mechanical tests unless it is stated in the enquiry or order that only the chemical analysis or the mechanical tests are required.

25 CHEMICAL COMPOSITION

The Ladle Sample Analysis (LSA) reported by the steel producer shall apply and comply with the requirement of Table 6.

Table 6 Chemical Composition for Cold Drawn Electric Resistance High Frequency Induction Welded Steel Tubes

(*Clause* 25)

Grade Designation (1)	**C** Percent *Max* (2)	**Mn** Percent *Max* (3)	**S** Percent *Max* (4)	**P** Percent *Max* (5)
CEW-1	0.12	0.60	0.04	0.04
CEW-2	0.25	1.20	0.04	0.04
CEW-3	0.35	1.30	0.04	0.04

NOTES

1 Micro-alloying elements like Niobium (Nb), Vanadium (V), Titanium (Ti) and Boron (B) either individually or in combination may be permissible in all grades but total micro-alloying elements should not exceed 0.20 percent in ladle analysis. However, in case of boron, the limit shall be 0.006 percent.

2 Tube Designation CEW-2: For each reduction of 0.01 percentages point below specified maximum of carbon (C), an increase of 0.05 percentage point above the specified maximum for manganese (Mn) is permitted up to a maximum of 1.60 percent.

26 CONDITION

Tubes shall be supplied in the condition specified in Table 7.

27 MECHANICAL PROPERTIES

The mechanical properties obtained from test pieces selected and prepared as specified in **8** shall be within the limits specified in Table 7.

28 LEAK TIGHTNESS TEST

When required by the purchaser, each tube shall be tested for leak tightness as in-process test at manufacturers works either by hydraulic test at a pressure of 5 MPa (50 Bar) or alternatively by eddy current test, in accordance with the requirements given under **23**.

Table 7 Mechanical Properties for Cold Drawn Electric Resistance Welded/High Frequency Induction Welded Steel Tubes (CEW)

(*Clauses* 26 *and* 27)

Grade Designation (1)	**Condition** (2)	**Tensile Strength,** MPa (kgf/mm^2) *Min* (3)	**Yield Stress,** MPa (kgf/mm^2) *Min* (4)	**Crushing Test** Percent *Min* (5)
CEW-1	Annealed/normalized	310 (32)	160 (17)	50
	As drawn or as drawn and tempered	430 (44)	370 (38)	25
	If subsequently annealed, brazed or welded	330 (34)	180 (19)	—
CEW-2	Annealed/normalized	430 (44)	270 (28)	50
	As drawn or as drawn and tempered	550 (56)	450 (46)	25
	If subsequently annealed, brazed or welded	430 (44)	270 (28)	—
CEW-3	Annealed/normalized	470 (48)	340 (35)	50
	As drawn or as drawn and tempered	590 (60)	430 (44)	25

NOTE — 1 MPa = 1 N/mm^2 = 1 MN/m^2 = 0.102 kgf/mm^2.

ANNEX A

(*Clause* 23.1)

EDDY CURRENT TESTING OF TUBES AS AN ALTERNATIVE TO THE HYDRAULIC LEAK TIGHTNESS TEST

A-1 METHODS OF TEST

A-1.1 The tubes shall be tested for imperfections using a concentric coil or segment coil or a rotating tube or rotary probe eddy current technique.

A-1.2 The tube shall be sufficiently straight to ensure the validity of the test and the surface shall be free from any foreign matter that would interfere with the interpretation of the test.

A-1.3 Two methods of test are permitted (at the manufacturer's option). The equipment may be located on or off the tube mill.

A-1.3.1 ***Method A***

The tube to be tested is passed through the (a) concentric test coil (applicable to welded or seamless tubes), or (b) segmental coil covering the weld and +15° arc from weld line (applicable to welded tubes) on either side.

A-1.3.2 ***Method B***

The tube to be tested or the test coil assembly is rotated and translated relative to each other so the test coil describes a helical path over the tube surface. The pitch of the helical scan shall ensure that the whole of the tube surface is effectively covered. This method is applicable to seamless tubes only.

A-2 CALIBRATION OF TEST EQUIPMENT

A-2.1 The equipment shall be calibrated using standard tube containing holes as defined in **A-2.2** for Method A or standard notches as defined in **A-2.3** for Method B. The standard tube for off-line equipment shall have similar electromagnetic properties and same diameter and thickness as the tube to be tested. For online equipment, running tube may be considered as standard tube.

A-2.2 Method A

The standard defect shall be a circular hole drilled radially completely through the tube wall on the weld zone. The diameters of the drills required to make these holes shall be as follows:

Nominal Bore of the Tubes (mm)	*Drill Diameter (mm)*
Up to and including 101.60	1.2
>101.60	1.6

A-2.3 Method B

The standard test piece shall have a longitudinal notch 0.8 mm or less in width machined parallel to the tube axis on the outer surface of the tube. The depth of the notch shall not exceed 12 percent of the specified thickness of the tube or 0.3 mm whichever is greater. The length of the notch at full depth shall not exceed 50 mm.

A-3 CALIBRATION PROCEDURE

A-3.1 The equipment and test coils shall be adjusted to produce in a consistent manner a clearly identifiable signal from the standard defect(s) on the standard tube and this signal shall be used to set the triggrer/alarm level of the equipment. For calibration purposes the relative speed between the standard tube containing standard defect and the test coils shall be the same as that used during the production.

A-3.2 The calibration of the equipment shall be checked at the commencement of a new size rolling campaign and verification of calibration at intervals not exceeding 4 h.

A-3.3 If on checking during production testing the reference standard defect is not detected even after changing the sensitivity by 2 dB to allow for equipment drift, the equipment shall be recalibrated. Following recalibration, all tubes tested since the previous check shall be retested, unless recordings from individually identified tubes are available that permit classification of those tubes into 'suspect' and 'acceptable' categories.

A-4 TEST PROCEDURE

Pass the tube to be inspected through the test unit at the appropriate production speed, maintaining the production speed constant with +10 percent under conditions identical to those used in the calibration of the equipment.

NOTE — Identical conditions include all instrument setting, mechanical motion, positioning of the encircling coil(s) in relation to the tube and any other factor that affect the validity of the technique.

A-5 ACCEPTANCE

A-5.1 Any tube producing a signal lower that the signals from the standard shall be deemed to have passed this test.

A-5.2 Since NDT systems are known to be sensitive to some features which do not cause leak, the tube rejected by NDT may be retested hydraulically and whatever tubes pass the hydraulic test shall be accepted.

A-5.3 The tubes rejected in **A-5.1** may also be retested off-line NDT equipment. Those which do not produce reject level signals shall be accepted. Others may be accepted after cropping off the portion producing reject level signals.

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Amendments Issued Since Publication

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